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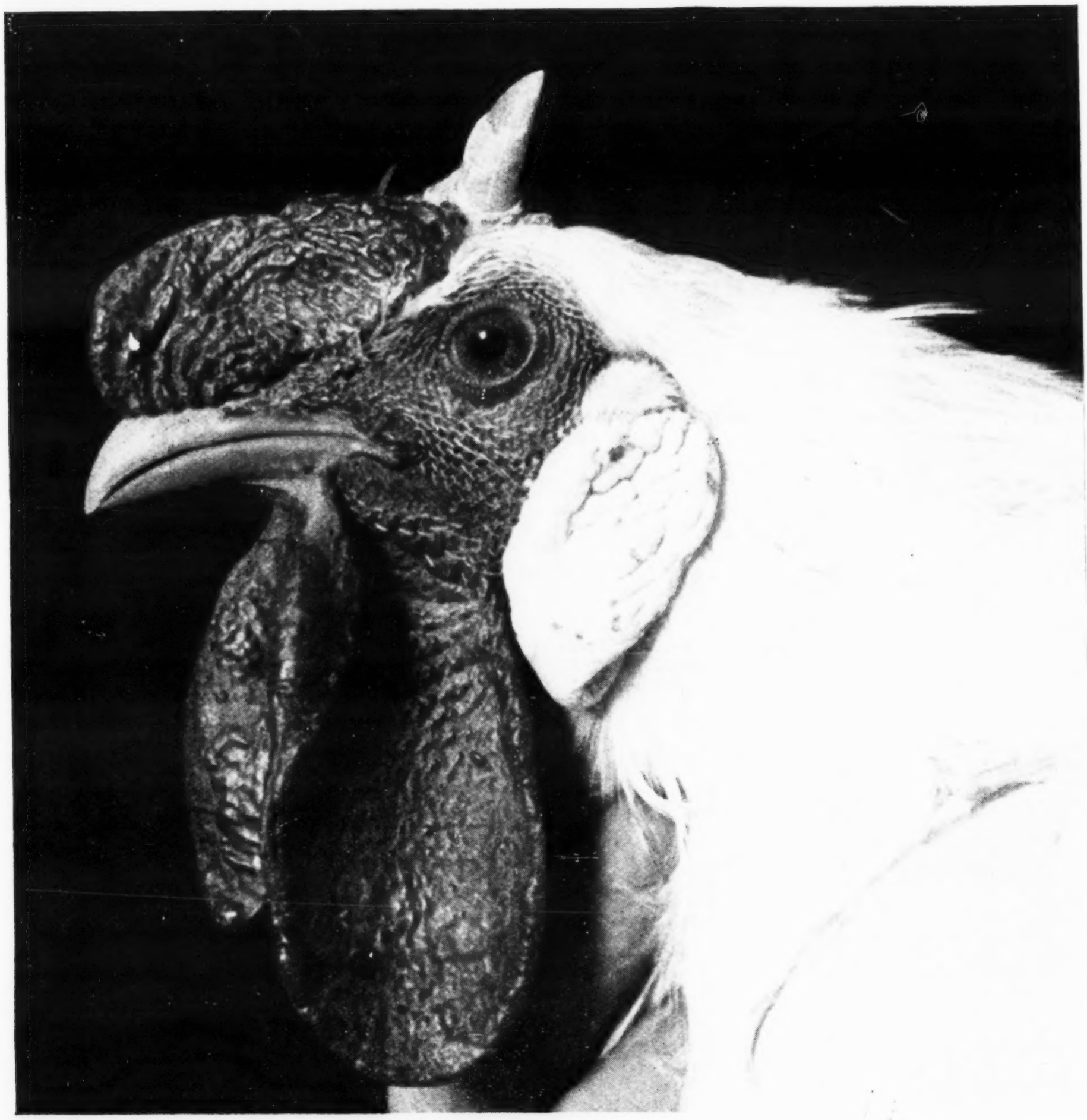

A SYNTHETIC UNICORN

Errors in Development

A Haploid Tomato

Oranges of the Orient

VOLUME 20 JANUARY, 1929 NUMBER 1

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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IN THIS ISSUE

INTEGUMENTAL GRAFTING IN THE DOMESTIC FOWL
By A. W. Kozelka 3

ERRORS OF DEVELOPMENT (A Review)
By Paul Popenoe 15

WHEAT ALBINOS
By W. K. Smith and J. B. Harrington 19

A HAPLOID MUTANT IN THE TOMATO
By E. W. Lindstrom 25

PREMATURE WHITENING OF THE HAIR
By Humphrey J. H. Hare 31

THE BEST ORANGES OF THE FAR EAST
By Tyozaburo Tanaka 37

BOOKS RECEIVED 14

FROM THE CRADLE OF THE JERSEY BREED 30

CORRESPONDENCE 32
Claw-fingers an Atavism? — Possibilities of Honey Locust Hybrids—Fertile Abyssinian Mules.

THE BEGINNINGS OF WISDOM 34

POPULARIZING THE DASHEEN 46

COMING

E. D. Metcalf

An Appreciation

A glimpse into a wide and varied experience of life which produced a remarkable philosophy.

Ectogenesis in Plants

Raising hybrid embryos outside the seed has interestng possibilities.

Gatling-Gun Maize

A heritable variation of unusual appearance.

Twins Reared Apart

Unquestionably identical twins —one reared in the crowded Chelsea district of London and the other in a small town in Canada—what has been the effect on mind and personality?

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A UNICORN OF THE CHICKEN YARD

Frontispiece

This "horn" is in reality a spur from the leg of the same individual transplanted to its present position when the chick was very young—about a year before the photograph was taken. Such tissue transplants throw light on the development of secondary sexual characters and on problems of tissue differentiation. Autografts (transplantation of tissue to a different part of the same individual) are more easily made than homoiografts (transplantation from one individual to another). In the latter the grafts are frequently absorbed, or tissue antagonism prevents normal growth.

INTEGUMENTAL GRAFTING IN THE DOMESTIC FOWL

Transplants of Combs, Spurs and Feathers in the Study of Sex-Dimorphism

A. W. Kozelka

University of Pittsburgh

THE usual method of study of the secondary sexual characters in the domestic fowl has been by means of gonadectomy and gonad transplantation. In the following study the writer has departed from the usual procedure by transplanting the various secondary sexual structures themselves from one individual to another of the opposite sex. Incidentally, observations were made on the question of the specificity and differentiation of the various tissues and on tissue absorption and antagonism.

The work has been confined exclusively to the white and to the brown leghorn. These breeds were chosen on account of their early sexual maturity and marked sexual dimorphism. They are also in all probability more hardy than most of the other breeds. The operations were performed within the first three days after hatching. The grafted portions were held in place by suturing or by the use of adhesive tape, the latter proving to be the more satisfactory of the two methods.

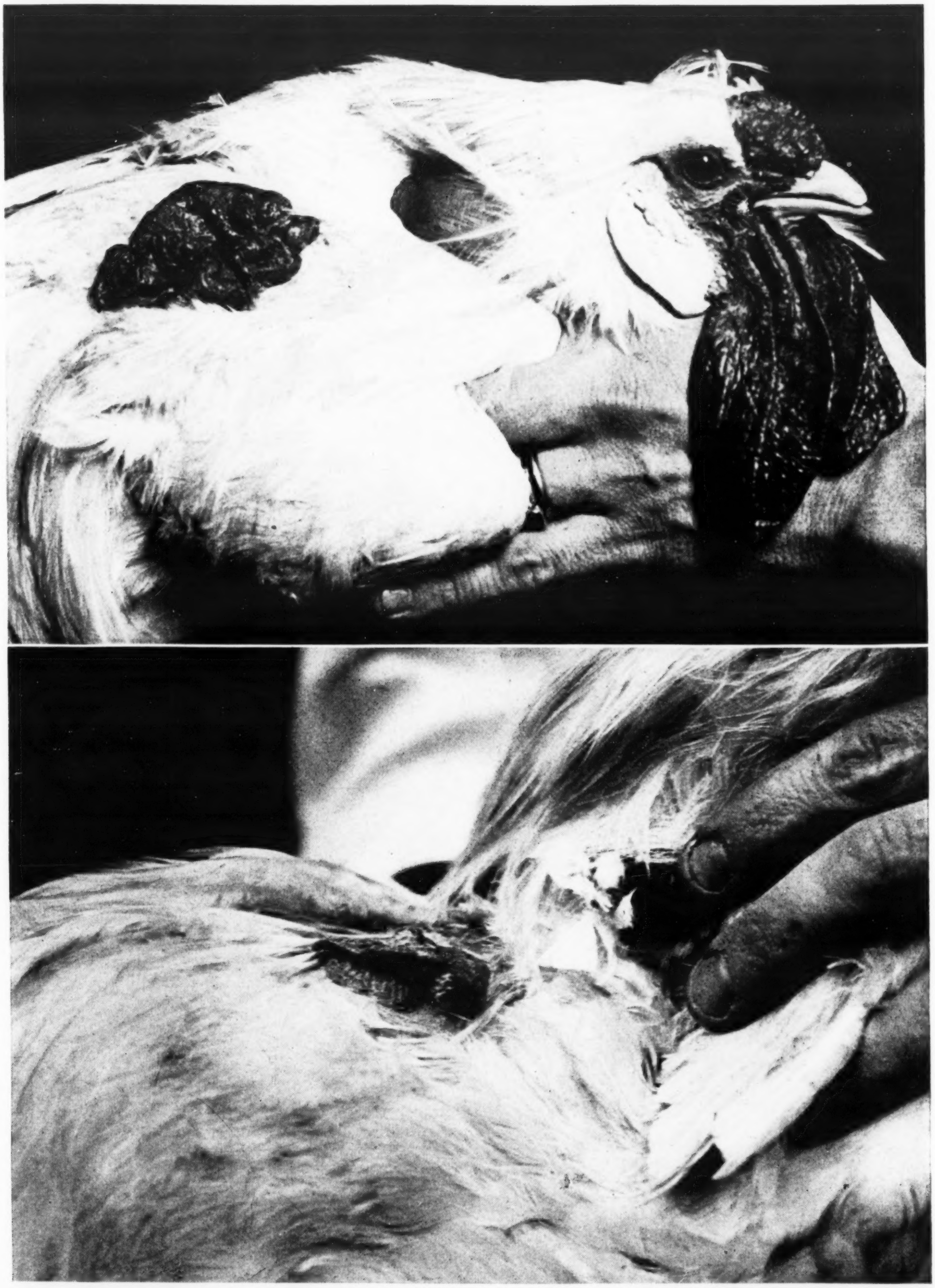
The experiments here reported involved a total of 175 positive grafts including birds eight months of age or over. At this age the secondary sexual characters are markedly different in the two sexes. Of the 175 grafts, 84 are homoiografts* only 22 of which persisted until maturity. Classified according to tissues, 51 are spur grafts, 39 comb grafts, 23 feather grafts. The latter classification does not include the 62 grafts that were absorbed during the life of the bird.

Comb Grafts

Considerable variation was encountered in the autoplastic† comb grafts. While the normal symmetry was maintained in most cases, the shape of some of the grafted combs varied from an irregular mass to a rosette effect. In some cases this was due to the technique and in others to the closing in of the surrounding tissues, thus making the comb force its way through a small opening. The size differed considerably in the two sexes, that of the female being proportionately smaller than that of the male. Figures 1, 2, 3, and 4, among others, are typical of the comb grafts. It appears that the comb grows best in situ. On all other parts of the body it is usually somewhat smaller than in the normal position. This is especially true in the female. Whether the difference is due to the upsetting of growth factors, to blood supply, or to some other conditions has not as yet been determined. Gross observation indicates that normal vascularization has taken place in all the comb grafts. However, all are insensitive to stimuli indicating that no innervation has taken place.

Only seven of the homiografts persisted until maturity, distributed as follows: one female and three male combs with females as recipients and two female and one male comb with males as recipients. These grafts would seem to indicate that the ovary has an inhibiting effect on the development of the male comb. However, greater vascularization takes place than in

*Homoiograft=transplantation onto the body of another individual of the same species.
†Autoplastic graft (autograft)=transplantation on the body of the same individual.



COMB GRAFTS ON BACK

Figure 1

Above is shown an autoplastic single-comb graft approximately ten months after operation. Below is shown a homoioplastic graft in which a single comb from a female has been grafted on to the back of a male (photographed about eight months after operation). The female type of comb has retained its normal characteristics in spite of the "male environment" in which it has developed.

SPUR AND COMB GRAFTS ON LEGS

Figure 2

On the left is a female, on the right leg of which two male spurs have been grafted. (Photographed approximately four months after operation.) The control spur in the normal position on the left shank indicates the usual development of the female spur at this age. In spite of the "female environment" in which they have developed the genetic constitution of the male spurs has caused them to continue characteristic male development. On the right is shown an autoplastic graft of a rose comb on the leg of a rooster, approximately one year after the operation. The unusual situation has not arrested normal development of comb tissue.

TWO MALE COMB AND SPUR GRAFTS

Figure 3

Homoioplastic grafts of spur and comb from one male to another approximately eight months after operation. The control spur is in the normal position on the left.

AUTOPLASTIC COMB GRAFT

Figure 4

Graft of single-comb on female, approximately twelve months after operation. Usually in comb grafts the normal shape was maintained; in others it varied from an irregular mass to a rosette effect.

corresponding grafts from females. The one female comb with the male as a recipient is of the characteristic female type.

Feather Grafts

The autoplastic feather grafts differentiate normally on any part of the body, in that both the original shape and color of the feathers are maintained. Of the homoiografts attempted, only one persisted long enough to produce adult plumage. In this case white of the donor was retained on a brown fowl. Because of the tendency on the part of the individual to pick the follicles, no observation was made on the shape of the feather. Danforth, who transplanted feather tissue from one breed of fowls to another, found that the pattern and the color are fixed before hatching while the sexual differentiation of the feathers is determined by the host rather than by the donor. A difference in the rate of growth was of special interest in connection with the feather grafts. This was especially evident when feather integument of a high rate of growth was grafted on to the scaly tissue of a low rate of growth. Such grafts would result in the outpouching of the skin, resembling a tumorous growth. A similar result was obtained in some of the homoioplastic feather grafts, but in all except the above mentioned case, follicles were absent.

Spur Grafts

In contrast to the variability of the comb grafts, consistent results have been obtained thus far in all the work on the spurs. In the male it appears that the spur will differentiate with slight variation in form on any part of the body. This is well illustrated in Frontispiece and Figures 3, 8 and 9. However, there is an indication on some of the immature birds that the male spur may remain juvenile on the region of the fluff. On the shank the grafted spur is often sightly larger than the control. This is especially evident during the early stages of differentiation. On other parts of the bird differentiation takes place at a later age but eventually the spur becomes as large as the control. The characteristic attachment to the underlying bone is not necessary for normal development. In fact, none of the spurs except those of the shank have become attached to the bony substratum even when this is present. The female spur behaves otherwise in that it differentiates normally only from the scaly tissue of the shank. On all

MALE SPUR ON FEMALE

Figure 5

Homoioplastic spur from male donor on site of right spur, approximately seven months after operation. The control spur on the left shank shows the normal development of a female spur at this age.

AUTOPLASTIC SPUR GRAFT ON FEMALE

Figure 6

The spur on the right leg has been transplanted on the hock. The photograph shows development twelve months after operation. This indicates that the development of the male spur shown in Figure 5 is not due to stimulus caused by transplanting, but is a result of the genetic constitution of the spur tissue.

SPUR GRAFTS ON BACK

Figure 7

Two spurs grafted on the back of a hen, approximately a year after operation. The spur on the left is from a male; that on the right is one of the hen's own spurs transplanted to this position. The male spur has developed in the characteristic way. The autoplastic female spur has remained undeveloped.

SPUR GRAFTED ON BACK

Figure 8

One of this rooster's own spurs grafted on his back, approximately ten months after operation. In the male spur transplants grow equally well on any part of the body.

other parts of the body it remains partially or wholly juvenile. An autoplastic spur on one bird which has not yet attained maturity appears to be an exception to this. In this case, however, the control spur is likewise abnormally large. A typical female spur is illustrated by Figure 6 and by the juvenile spur on the right side of the body in Figure 7.

Grafting a spur in situ or on any part of the shank usually has a slight stimulating effect. Though the mass of the spur may not be greater, the length usually exceeds that of the control. Grafting a portion of a spur failed to produce normal growth. The size is about proportional to the part grafted. No cases of regeneration were observed, indicating that the spur is entirely of integumental origin.

Of the homoiografts with the male as the recipient, only one spur persisted, and that was from a male. In this case it had all the characteristics of the male spur. With the female as a recipient thirteen grafts persisted, six from female and seven from male donors. Of the former all were characteristically of female type, while the latter were of male type. According to the literature on the secondary sexual characters of the domestic fowl, the spurs grow best in the total absence of the gonads, the ovary having a greater inhibiting effect than the testes. The spurs of a capon are usually somewhat longer, smaller in diameter and more pointed than the normal male spur. Upon removal of the ovary, the spurs assume the male form and upon removal of the compensatory gonad on the right side of the body, the spurs become of the capon type. So far as the writer is aware, no very definite distinction has been

AUTOPLASTIC SPUR AND COMB GRAFTS

Figure 9

Transplants of his own comb and spur on a rooster, about nine months after operation. The control spur on the right shank is not quite as large as the grafted spur. In some cases grafting seems to stimulate growth of the tissue.

made between the spurs of the two sexes. It was merely assumed that the ovary has a greater inhibiting effect upon the spur than have the testes. According to the evidence above, male and female spurs are genetically different. While the ovary has an inhibiting effect upon the female spur, it does not materially influence the growth of the male spur. Unfortunately, none of the spurs from a female with the male as the recipient persisted on any of the mature birds. However, eight grafts on birds ranging from twenty to twenty-eight weeks of age may be indicative of future results. Two of the spurs are approximately the same size as an adult female spur, while the remaining six spurs are entirely or wholly juvenile. Whether factors other than tissue antagonism are concerned has not been determined.

Absorption and Tissue Antagonism

The most serious difficulty encountered during the course of the experiments was due to tissue antagonism and absorption, a question concerning which there is a wide divergence of opinion in the medical world. Baldwin, at one extreme, contends that in man fifty per cent or more of the homoiografts are possible. Moss believes that tissue from one individual to another can be grafted successfully only when the two individuals concerned belong to the same blood group. On the other hand, Ingebrigsten in his work on cats found that the results in a group in which there was interagglutination differ in no striking way from those obtained in a group in which there was no interagglutination. McWilliams states that "for every rare homoiograft that succeeds there will be at least twenty-five failures." Holman, at the other extreme, contends that homoiografts exist only in fable and not in fact. This view is also held by Schoene, Gatch, Perthes and Lexer, the latter emphatically stating that accounts of successful homoiografts may be relegated to mythology.

The results obtained during the course of this work indicate that the percentage of initial "takes" in homoiografts is high, but of the positive grafts, seventy-four per cent are subsequently absorbed, leaving only scar tissue. Absorption takes place either by rapid disintegration or by gradual replacement of the grafted tissue, extending over several weeks. Usually complete absorption takes place before the end of two months. This was best demonstrated where contrasting tissues were used, such as the scaly tissue of the foot, grafted on feathered integument or a comb on the shank or feathered region of the body. In contrast to the high percentage of absorption of the homoiografts, no replacement was observed among the autografts.

Tissue antagonism was expressed by excessive vascularization and swelling of the surrounding tissue. In three cases sloughing off of the skin was observed on various parts of the body. This was believed to be due to hypersensitivity to the foreign tissue. Removal of the grafts resulted in a rapid recovery.

The nature of the difference in the tissues between any two individuals is not known, but it seems comparable to the phenomenon of protein sensitivity in man. Whatever the biological difference might be, there is less antagonism and fewer cases of absorption among half or full brother and sister birds. In one lot of birds not otherwise included in this paper, twenty-one of a total of forty-five grafts, or forty-six per cent persisted after sixteen weeks. While some of these may still be absorbed, it nevertheless serves as an indicator of the percentage of absorption among related birds.

It is of interest to note here that Collins and Adolph in their work on the amphibian, Diemyctylus, encountered little or no antagonism of tis-

sues in homoiografts. However, a reorganization always took place so that the graft would partially conform in gross appearance to the surrounding pattern of the host skin. This would seem to indicate that while the integumental tissues of the bird are more specific, resulting in greater tissue antagonism, they are not as plastic as those of the amphibian in that they retain their original characteristics following transplantation.

The writer wishes to express his gratitude to Professor H. H. Collins for his suggestion of the original problem and for his unfailing interest and kindly advice throughout the course of the work.

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*Contains a good summary of the literature on this subject.

Books Reviewed

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the Journal will be reviewed in later numbers.

Scientific Papers of William Bateson: Two volumes containing practically all Bateson's contributions to purely scientific journals, together with portions from two of his earlier books. Edited by R. C. Punnett. Pp. 955. 2 Vols. Price, 42 shillings each. London, Cambridge University Press, 1928.

The Intradermal Tuberculin Test in Cattle: Special Report Series No. 122. Collected Results of Experience, by J. Basil Buxton and A. Salusbury MacNalty. Pp. 64. Price, 45c., plus postage. London, His Majesty's Stationery Office, 1928.

Die Cytologischen Grundlagen der Vererbung: By Karl Belar. Handbuch der Vererbungswissenshaft. Vol. 1, part 5. Pp. 412. 280 text figs. 2 plates. E. Baur and M. Hartmann, Berlin, 1928. Subscription price, 40 R. M.; separately, 80 R. M.

The Kahn Test: A Practical Guide. "Detailed technique, including discussion of apparatus, reagents, standardization of antigen, routine tests and various other procedures with serum and spinal fluid." By R. L. Kahn. Pp. 201. Nine chapters. Price, $4.00. Baltimore, The Williams & Wilkins Co., 1928.

An exhaustive treatise on the test that is coming widely into use to supplement, some believe to replace, the classical Wasserman test.

Old Trails on Fire: "A New Life Novel in 33 Short Stories." By Julius Reuter. Pp. 403. 33 Chapters. Price, $2.50. Cleveland, Odin Publishing Co., 1929.

Father Gregor of Brünn goes slumming among the aristocracy of a jazz age, where bullets, bombs and buncombe make race suicide seem like a pale "parlor pink" tea. In the excitement he gets his genotypes mixed on page 1. We trust he escapes with nothing worse by the close of Episode 33.

Trends in Philanthropy: A Study in a Typical American City. By Willford Isbell King, of the staff of the National Bureau of Economic Research, Inc. Pp. 78. Price, $1.75. New York, National Bureau of Economic Research, Inc., 1928.

Growth: Introduction by William Jacob Robbins. An analysis of the Course of Growth and Senescence by Samuel Brody, Some Relations Between Growth and Nutrition by Albert Garland Hogan, Some Aspects of Form and Growth by Clarence Martin Jackson, and Physiological Factors Regulating Normal and Pathological Growth by Charles Wilson Green. Pp. 189. Five chapters. Price, $3.00. New Haven, Yale University Press, 1928.

ERRORS OF DEVELOPMENT

A Review

IF one tries to follow in imagination the endlessly complicated series of processes which results in the production of a full-grown man from a tiny, fertilized egg-cell, the attempt is quickly given up. It is too intricate even to be imagined, much more to be followed in the laboratory. The delicate adjustments, carefully timed, which are required to make such a small part of the body as a perfect eye, would alone baffle the skill of the most expert mechanic.

The genes can turn out a good piece of workmanship in a surprisingly high percentage of cases, though they have what looks like only the most simple material to work with, because they have been working together on similar jobs for hundreds of millions of years. They have made, and discarded, almost all the mistakes that can be made.

But since certain mistakes are in the nature of the material and the processes, these occur over and over again. The introduction of a single new gene which does not work in complete harmony with the rest of the crew, may spoil the perfection of the product. If a given series of cell divisions is started too soon, or too late, with reference to the others going on around it, all subsequent operations in that part of the body will be disturbed and the baby will be born with cross eyes, or six fingers, or a club foot, or some similar defect, as the consequence of what was at first apparently a very trifling blunder way back in the line of development, due to the incompetence of a single one of the perhaps 20,000 genes that were all at work simultaneously on the organism.

It is not strange, therefore, that the bulk of the human traits that can be shown to be due primarily to the action of some single gene, are abnormalities. It is scarcely too much to say, broadly, that abnormal traits are due to the action of a single gene (or several of them); normal traits due to the concurrent action of a multitude of genes

The inevitable result has been that detailed treatises on human heredity have had to deal mostly with these errors of development, in order to deal with simple traits that could be described and followed through one generation after another. Insofar as knowledge of human heredity is precise and definite, it still depends largely on these simple pathological traits, although everyone knows that the more fundamental, compound traits are the ones that are of the greatest eugenic significance.

One of the most recent and useful contributions to this important though limited field is that of Berta Aschner of Vienna who, with an orthopedic collaborator, has brought together the facts concerning the inheritance of defects in the locomotor apparatus[1]. Richly illustrated with photographs and pedigree charts, the book will stand for some time as an indispensable source of information and suggestions for anyone who has occasion to delve into this sort of material: though it may as well be said at the outset that the author's attempts to apply the refinements of genetics to this material are too frequently laughable or pathetic, according to one's mood. She has "discovered" more cases of linkage in man than all the other investigators in the world put together—infinitely more, very literally, since the total number demonstrated by others is zero, if exception is made of the sex-linked traits.

Naive Genetics

The style of her interpretations may be illustrated by a single citation. She has a gene (A) whose business it is to see that the proper number of parts is produced in a given case. This has (B) a pathological allelomorph

which is capable of any sort of crooked work, from the doubling of a fingernail to the production of identical twins, the region of its application being determined by (C) a second pathological gene that is a "pilot". These two are linked. Pathological C is regional, but there is also a specific pathological D which shows exactly where a job is to be done, and is at nearly the same locus as C. Their joint effect is the more pronounced, the more peripheral is the site of their operations. Linked with this whole group of genes is a fifth (E) which lays down five fingers or toes, as the case may be; and it also has (F) a pathological allelomorph, etc., etc., the whole superstructure being built, in the first place, upon a *Status Degenerativus!*

But if one will not go to Dr. Ascher for a profound grasp of genetics, one will go with profit for a body of assembled evidence about the as yet unanalyzed effects of genetic changes. That these errors in development are mostly genetic, and not due to deformation in the uterus, or anything of the sort, she makes plain. Some anomalies do result from uterine pressure, but this can not account for them ordinarily, since most of them arise during the first 60 days after conception, when there is little likelihood of crowding inside the womb.

Anomalies of the fingers, of which probably 50 if not 100 could be enumerated, are detailed at some length, beginning with the familiar polydactyly. Brachydactyly or short-fingeredness is generally credited with being the first Mendelian trait discovered in man: it was described by W. C. Farrabee in a Pennsylvania family in 1905 and independently by H. Drinkwater in a British family in 1908.

Dr. Aschner believes that all grades of transition can be found between this and the mere "degeneration" of the little toe which is so common, or of the little finger, which is much less so. The fifth toe is reduced to two segments, and the joints of these are often unworkable, in one-third or more of Germans and Americans; whereas 80 per cent of Japanese show this condition. In other words, the diminished little toe is no more common among whites than the complete toe is among yellow people. The fact that the defect is thus common among Japanese, who have not been given to the wearing of tight shoes, is sufficient evidence, if any were needed, that it is not due to the inheritance of the effects of pressure. It is likewise commonly found among the mummies of ancient Egyptians.[2]

Future of the Human Eohippus

The Aztecs are said to show frequent reduction of the little finger in a similar way. Something of the same sort seems to have taken place long ago on the opposite side of hand and foot respectively, leaving Pollex and Hallux with only two segments each; and it looks as if evolution is tending to depreciate the digits of man as it has those of the horse. Cartoonists who have racked their brains to picture the superman of the future, after evolution shall have had its way for some aeons more, have not yet pictured him as running his course upon his middle toenail: perhaps they have overlooked a real clue.

The frequency of this diminished little toe among the Japanese is associated with their smaller stature, just as among whites the brachydactylous individual was found to be shorter than his normal brethren. The proportions of the entire skeleton are of course altered.

Not only in gigantism, which is familiar enough, but in partial gigantism, there are all possible grades between extremes, which makes it appear that they are quantitative variations of one process. The rare condition in which an entire half of the body is enlarged, however, is plausibly explained as the first stage in a process that would culminate in the production of identical twins.[2] In the more irregu-

lar partial gigantism, one may exhibit any mark from a single overgrown finger on up. Here is a man whose right leg is 1½ inches longer than his left. His father had the same peculiarity. It can scarcely be referred to anything except heredity.

Of the congenital deformities, dislocation of the hip is perhaps the commonest, occurring in almost one baby in 1000, although clubfoot is a close second, and since the war is shown by some studies to have taken first place. This may be connected with an excess of male births due to a large crop of new marriages after the war[4]: clubfoot is twice as common in males as in females, whereas the weak hip that results in early (though not often congenital, strictly speaking) dislocation is found in eight girls to one boy. This high disproportion does not indicate that it is either sex-linked or sex-limited, but merely that the female hip is normally put together in an inefficient manner, so that the same strain applied to two hips will throw out that of the girl while leaving that of the boy unimpaired. The fundamental error in dislocation of the hip seems to be an underdevelopment of the pelvis on one side. On the whole, the victims seem usually to be well developed children, save in this one particular; whereas clubfoot is supposed to be rather more common among defectives and to go with a weakened nervous system, as in the poet Lord Byron.

Curvature of the Spine

Curvature of the spine is also ascribed primarily to heredity. Rickets too are sometimes present, but can not be considered the primary cause, for when present in a given family, why should it affect merely the spine and not the legs, for example? More than two-thirds of all cases of scoliosis are bent toward the left. Most people have a slight curvature of the spine to the left between the shoulders, and to the right in the small of the back, and scoliosis seems merely to accentuate this. Most of the cases of primary abnormal curvature to the right are said to be in families characterized by left-handedness.

The author goes to a good deal of trouble to find correlations among her traits, and for the cautious student this will be one of the most valuable parts of her work. Sometimes, on the mere doctrine of chance, a correlation can hardly be set aside as insignificant. Thus a defect of the knee-cap goes with defective thumbnails in many instances. As each of these defects is extremely rare, it seems unlikly that they would often occur together by chance: they are more likely to be both effects of the same gene, and this may furnish a clue for their further study.

Most of the defects as to which the author makes a definite statement, are listed as dominant, for example:

Dominants

Polydactyly
Syndactyly
Ektrodactyly
Patellar defect
Brachydactyly
Thumb with three phalanges
Hypophalangism
Aplasia
Multiple exostoses
Osteopsathyrosis
Dysostosis cleidocranialis

Recessives

Defect of long bones
Turmschädel
Luxation of hip
Club foot

Here as whenever she strays into the domain of genetics, the author is an unsafe guide. In the first place, whenever any defect of this sort is studied intensively, it is almost invariably found to behave in different ways in different families.

By way of illustration, web-fingers are markedly inherited, the connection usually being between the third and fourth fingers and, if so, almost always between the second and third toes in the same person. Most frequently, this trait behaves as a simple dominant. But there are well ascer-

tained cases in which it is a simple recessive, others in which it is in the X-chromosome (sex-linked), and another family history in which it appears to be passed only from father to son, never from mother to daughter, which would lead to the supposition that it is in the Y-chromosome.

In short, this common trait, due to a single difference in the germ-plasm—that is, a single gene—may arise from any chromosome and may behave in development in a variety of ways, according to the chromosome it is in and the genes which most directly modify it. To base any conclusions on the assumed fact that web-fingeredness is a simple Mendelian dominant would merely argue a lack of knowledge of the subject.

When Dr. Aschner goes on, then, to draw a conclusion to which she seems to attach a good deal of importance[5], one must cross one's fingers (unless they are webbed). This conclusion is that the normal genes are dominant in the portions of the limbs nearest the body and recessive in the extremities of these limbs; conversely, that the pathological allelomorphs of these normal genes are recessive near the body and dominant at the extremities.

The explanation is that the extremity of the limb—i. e., the hand or foot—is younger in the history of life than is the limb itself; and that the normal development of the phylogenetically older part of the body is better assured than that of the younger: there is more tendency therefore to variation in the hand or foot, in the finger or toe, than there is in the elbow or thigh.

This is a line of argument that is no stranger to readers of the speculative writings on evolution during the last century or so. It may have some truth in it. But the evidence to support it in the case of the locomotor apparatus is far from sufficient and until a great deal more real evidence is available, it can scarcely be considered anything more than a fantasy.

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WHEAT ALBINOS

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A REPRESENTATIVE WHEAT ALBINO

Figure 10

An albino wheat seedling which has been above ground for 14 days is shown along with a normal green plant of the same age. The white seedling has reached its maximum development and will soon die. Three genetic factors when present in the homozygous condition have been found to determine this lethal condition.

THE presence of pure white seedlings has been noted in a number of cultivated crops but, as far as the writers can ascertain, has not been reported in wheat. This paper is a report on the appearance of albinos in a wheat cross made at Saskatoon.

Previous Work

Of the many studies on white seedlings in plants some representative ones should be mentioned.

In 1911 East and Hayes[4] reported albinos in self-fertilized lines of maize in the ratio of one to every three normal green seedlings.

Lindstrom[8] in 1921 reported interesting results on the interaction of genetic factors governing the formation of green and yellow pigments in maize. A single recessive factor when present in the homozygous state, was found to inhibit chlorophyll development.

Demerec[3] made a detailed study of the relationships of different genetic factors conditioning albinism in maize. By inter-crossing different strains of maize he demonstrated the existence of at least seven different genes for white seedlings. Three of these factors proved to be simple Mendelian recessives. Two others were found to be duplicate genes, the progeny of a self-fertilized plant heterozygous for both of these genes segregating in a 15:1 ratio for green and white seedlings. The remaining two factors were also duplicate genes.

The artificial self-fertilization of some of the forage crops has resulted frequently in the occurrence of white seedlings. Hayes and Barker[6] and Clark[2] reported them in self-fertilized strains of timothy. Clark concluded that at least three genetic factors were necessary to explain his results. Kirk[7] found chlorophyll deficient seedlings in 21 out of 81 self-fertilized lines of red clover and of these 24 plants were albinos.

Albinos were reported in inbred rye by Brewbaker[1] but the genetic factors involved were not determined.

Albinos in barley crosses have been reported a number of times. While in most cases albinism in barley has been found to depend upon a single genetic factor, Nilsson-Ehle[9] reported the occurrence of green and white seedlings in a 9:7 ratio in a cross which he studied.

Experimental Results

A number of white seedlings (See Figure 10) were observed in the F_2 population of the cross, Vernal emmer (C. I. 3686) sometimes called White Spring Emmer × Marquis wheat in the nursery in 1927. These seedlings, upon emerging from the ground, seemed to be as vigorous as those having normal chlorophyll development. They grew with normal rapidity for a period of from six to nine days, then, having probably exhausted the food supply in the endosperms of the seeds, they gradually ceased growth, wilted and died.

During the winter of 1927-1928 another F_2 population was grown in the greenhouse. Under the more favorable environmental conditions there the albinos showed greater development than in the field. In some cases they were still fresh sixteen days after the first leaf had appeared. Some seedlings only got as far as the first leaf stage, the majority produced three leaves and a few managed to show their fourth leaves.

The F_2 population in the field consisted of 1233 green seedlings and 18 white ones. In the greenhouse the numbers were 958 and 20, respectively. Either set of figures gives a close approximation to a 63:1 ratio. The goodness of fit of the observed with the calculated values was tested by the $\boldsymbol{X}^2$ method (Fisher[5]). The value of $\boldsymbol{X}^2$ was 1.606, and P equalled .48. The good fit indicates the presence of three genetic factors governing the appearance of albinos.

F_3 seedling progeny of Vernal × Marquis F_2 plants were grown in the greenhouse in 1927-28. Owing to the expectation that some of the progenies would segregate according to the ratio 63:1, only families having 100 or more seedlings would, with a fair degree of certainty, reveal their genetic condition with respect to albinism. However, all of the progenies had fewer seedlings than 100 on account of certain unfavorable environmental conditions and the usual difficulties experienced with inter-specific wheat hybrids. Therefore, it was decided arbitrarily to consider only those progenies having 40 or more seedlings. Of the 167 F_2 plants grown to maturity, all but 31 were eliminated on this basis. The data from these plants are shown in Table I.

To determine the validity of assuming the ratios for the various families as shown in Table 1, the observed numbers of green and albino seedlings in each family were fitted to the expected numbers by the $\boldsymbol{X}^2$ method as illustrated in Table II. The high value of P (.82) shows that the classification of segregating families according to the ratios 3:1, 15:1 and 63:1 was accurate.

The following hypothesis seems to suit the results: Vernal (or Marquis) carries two recessive genes for albinism which are complimentary to a third gene for albinism carried by Marquis (or Vernal). The three genes when present together in the homozygous state inhibit the development of chlorophyll.

The $\boldsymbol{X}^2$ test of the number of green and white seedlings in the segregating families verified the three factor hypothesis. A further $\boldsymbol{X}^2$ test was made on the F_3 lines by fitting the numbers of families segregating according to the different ratios and the number of non-segregating families to the calculated numbers. There were 13 non-segregating families, 5 that showed a 63:1 ratio, 9 with a 15:1 segregation and 4 that segregated in the ratio 3:1. The expected numbers were 18.206,

TABLE I—Segregation of green and white seedlings of Vernal×Marquis F_3 progenies having forty or more seedlings.

No. of F_3 family.	Number of seedlings.		Probable Ratio
	Green	White.	
11	46	2	15:1
14	48	8	3:1
15	45	1	63:1
16	46	2	15:1
25	49	0	
26	51	4	15:1
27	43	0	
29	45	0	
31	46	5	15:1
33	40	0	
113	40	2	15:1
115	57	0	
117	36	5	15:1
123	44	0	
125	42	1	63:1
167	56	11	3:1
172	74	0	
174	76	0	
175	39	12	3:1
190	35	10	3:1
266	47	0	
269	53	5	15:1
278	74	0	
284	44	0	
285	52	1	63:1
296	44	2	15:1
297	40	1	63:1
299	56	0	
301	38	3	15:1
303	44	1	63:1
308	48	0	

TABLE II—Use of the X^2 method for testing the goodness of fit of the observed members of green and white seedlings in F_3 progenies with the expected numbers.

Seedling Classes.	Number of Seedlings. Observed	Calculated	O-C	$(O-C)^2$	$\frac{(O-C)^2}{C}$
15	46	45.00	1.00	1.000	.022
1	2	3.00	1.00	1.000	.333
3	48	42.00	6.00	36.000	.857
1	8	14.00	6.00	36.000	2.571
63	45	45.28	.28	.078	.002
1	1	.72	.28	.078	.108
15	46	45.00	1.00	1.000	.022
1	2	3.00	1.00	1.000	.333
Etc.	etc.	etc.	etc.	etc.	etc.

N (degrees of freedom)=18; X^2=12.422; P=.82.

3.937, 5.905 and 2.952, respectively. The value of X^2 was 3.770 and P equalled .29, indicating a good fit.

Discussion

The appearance of albino seedlings in Mendelian ratios in a cross between Vernal, a variety of *Triticum dicoccum*, and Marquis, a *T. vulgare* variety, is interesting in two respects. First, it is a phenomenon not hitherto reported in wheat as far as the writers have ascertained. Second, the occurrence of Mendelian ratios in this cross offers further indirect evidence that some *dicoccum* chromosomes mate regularly with *vulgare* chromosomes. The cytological findings of various investigators indicate that in crosses between *Triticum vulgare* and wheats containing 14 chromosome pairs, such as *T. dicoccum*, 14 *vulgare* chromosomes mate regularly with the chromosomes of the other species, leaving 7 *vulgare* chromosomes unmated. If one or more of the three factors for albinism in the case here reported are located in any of the seven *vulgare* chromosomes that find no *dicoccum* mates, it is difficult to see how the Mendelian results obtained could have occurred.

Summary

1. In the F_2 generation of a cross between Vernal (*T. dicoccum*) and Marquis (*T. vulgare*) approximately one sixty-fourth of the seedlings were albinos. These seedlings, after growing normally for a few days, died upon exhausting the food supply in their endosperms. In F_3 some progenies consisted solely of green seedlings, others were composed of green and white seedlings approximately in the ratios 3:1, 15:1 and 63:1.

2. The results showed that the varieties Vernal and Marquis carry three recessive genes for albinism, two of them being in one variety and the third in the other.

3. The appearance of white seedlings in Mendelian ratios in the cross Vernal × Marquis is evidence that some *dicoccum* chromosomes mate regularly with *vulgare* chromosomes.

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A HAPLOID MUTANT IN THE TOMATO*

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IN the winter of 1926, there occurred in an F_2 generation of 337 tomato plants (seed planted October 19, 1926, in the greenhouse), a single, dwarf plant that attracted my attention by its morphological variation as well as by its sterility. Because these hybrid cultures were grown to test linkage in the first chromosome of the tomato (carrying the dwarf, peach and ovate genes), the peculiar dwarf was first thought to have been caused by some disturbance of this chromosome; and accordingly it seemed to merit cytological investigation.

Preliminary observations† of the pollen mother cells by the iron aceto-carmine method proved clearly however that there only twelve, single chromosomes, the haploid number in *Lycopersicum*. Later this conclusion was verified by root-tip observations.

This haploid plant carried the genes *PdORY*‡, and hence was presumably due to the parthenogenetic development of a single-crossover gamete, as may be seen from the following genotypes of the parents:

Red Pear	×	*Dwarf Peach*
PPDDooRRYY		*ppddOOrryy*

In other words, the haploid was a dwarf, smooth (non-peach), oblate-fruited type with the orange-red fruit colors, having received the linked *dO* genes from the Dwarf Peach parent and the linked gene *P* from the Red Pear variety. There is some genetic evidence, however, indicating that the true genotype of the haploid is *pd O;* and that the peach gene in a haploid condition does not cause a full expression of the character.

The segregation of qualitative genes involved in this cross is recorded in Table 1 (the shape genes have been omitted because of their semi-quantitative nature, which makes it difficult to demonstrate accurately a sharp segregation in an F_2 generation).

The occurrence of this haploid in an F_2 generation of a varietal cross in which there was complete fertility, is different from the mode of origin of other haploids, most of which have arisen in F_1 generations of species crosses involving incompatibility. This is true of the following haploids:

Nicotiana tabacum (Clausen and Mann.[4])
Triticum compactum (Gaines and Aase.[5])
Crepis capillaris (Hollingshead.[6])
Solanum nigrum (Jörgenson.[7])

The Datura haploids arose presumably in normal, self-pollinated, diploids as result of a stimulus of cold temperature.[2]

It is worth noting that of the six haploids known at the present time, all except two (in *Crepis* and wheat) fall within the Solanaceae family. This would seem to be more than a coincidence for it appears that other families in the plant kingdom have been investigated genetically and cytologically as intensively as the nightshade family.

*Paper No. 25. Department of Genetics, Iowa State College, Ames, Iowa.
†Made by F. B. Hull, then graduate assistant in Genetics.
‡Factor symbols and characters are as follows (from Lindstrom[8]).

Pp—Smooth vs. peach (pubescent fruit)	Linkage	group	I
Dd—Tall vs. dwarf growth habit	"	"	I
Oo—Oblate vs. ovate fruit shape	"	"	I
Rr—Red vs. yellow flesh color	"	"	II
Yy—Yellow vs. colorless fruit epidermis	"	"	III

HAPLOID AND DWARF TOMATO PLANTS

Figure 11

Young tomato haploid on right compared with normal dwarf type. Both approximately the same age.

Description of the Tomato Haploid

The original haploid plant has now been under observation for more than a year and a half, having passed through five generations of cuttings, comprising approximately 300 individuals. In stature it is of the dwarf type, smaller in height and in spread of plant (Figures 11 and 12) than the diploid. It grows rather luxuriantly, putting out many axillary branches; and cuttings from these are easily rooted. Its dwarfness is caused both by a shorter internodal length as well as by leaves smaller in length and in breadth (Figure 13). The main stalk is decidedly smaller in circumference than that of the normal diploid. The flowers also are distinctly smaller, but appear normal in structure, carrying a mean sepal and petal number of six or seven. The anthers, however, are not fully developed, evidently because of the abortion of the microspores.

The haploid is almost completely sterile, particularly in the staminate phase. I have attempted at least sixty crosses on different varieties using haploid pollen, but with no success whatsoever. An examination of the pollen grains shows a very high percentage of small and shriveled or abortive grains. Plump and normal appearing pollen grains are occasionally seen, but on the whole less than 1.0 per cent could thus be classified. This percentage seems to vary with the age of the plant (or cutting) and also with external conditions for I have seen occasionally as high as 10 per cent plump pollen grains in the younger plants.

When used as a female parent, the haploid has given some seeds. Of nearly 100 pollinations by different

HAPLOID TOMATO COMPARED WITH NORMAL

Figure 12

Haploid tomato (12 chromosomes) on the left compared with standard or tall type. Both same age, and mature.

LEAVES OF HAPLOID AND NORMAL TOMATO PLANTS

Figure 13

Leaves of normal tall (left), haploid (center) and normal dwarf type.

tomato varieties eleven have resulted in a set of fruit, but then with very few plump seeds (at most three to seven seeds in a single fruit), some of which germinated. At the present time there are growing 42 plants from such crosses. All appear absolutely normal diploid in foliage. It should be mentioned that one of these crosses involved a dwarf variety as the staminate parent. Three plants from this cross are now growing. They are normal dwarfs proving conclusively that the haploid is genetically a dwarf. Pollen studies have shown that 41 plants have as perfectly developed pollen grains as normal varieties. One plant shows a distinct percentage of pollen abortion.

Some attempts have been made to self-fertilize the haploid but with no success. Three small fruits have set with open-pollination; and because of the structure of the tomato flower, it is believed that these are actually self-pollinations. Three plants from such seed are now growing. They are dwarfs with normal, diploid foliage.

The fruits obtained as noted above were all very small (approximately 24 × 28 millimeters) and abnormal. Containing only a few seeds they obviously did not develop the true, genetic fruit size of the haploid. The number of locules of the haploid is probably more than four or five, but since the fruit formation is so abnormal it is impossible to ascertain the exact number. The color of the haploid fruit is orange-red, due to the dominant red flesh and yellow epidermis characters.

Cytology of the Haploid

Aceto-carmine preparations of pollen mother cells show twelve, univalent chromosomes, practically round in shape. There seems to be no attempt at pairing; so presumably there are no homologous chromosomes among this number. Twelve may then be considered as the basic number for the tomato. There is an attempt at reduction or separation of chromosomes at the first (meiotic) division, apparently not an orderly procedure. I have seen six chromosomes going to either pole, seven to one and five to the other, etc., in this pseudo-reduction division. Figure 15.

It would seem reasonable to suppose that, in view of the very high percentage of abortive pollen grains, those microspores which receive less than twelve chromosomes abort. This is verified to some extent by the very abnormal attempt at tetrad formation. At this stage an irregular series of microspore groups may be seen such as diads, pentads, giant cells and other abnormal formations. The fact that the progenies from the haploid (as the pistillate parent) all exhibit normal fertility and normal morphological structure would indicate that the only functional megaspores were those with the full complement of twelve chromosomes.

Paraffin sections of the root-tips, using both Bouin's and Carnoy's methods, give ample verification for the haploid count. At least 47 cells have been observed with twelve chromosomes, these being less condensed in form than those noted in the pollen mother cells with the aceto-carmine method. A drawing of a root tip cell of the haploid appears in Figure 14.

One cell was noted to possess only eleven chromosomes. It is of some importance to observe also that occasional cells in the root tips of the haploid possessed more than twelve chromosomes, some having the diploid number, twenty-four. Three such cells were found.

Discussion

In view of the occasional formation of diploid cells in the roots of the haploid, it might be expected that in time one of these should occur in the meristematic tissue of the aerial portion and be included in a growing tip. Under such circumstances I would expect the reappearance of the normal

diploid foliage and the return of complete fertility.

But this has not yet happened in the course of twenty months, during which time at least 300 cuttings have been made. At least one hundred cuttings have been carried beyond the stage of the fifth flower cluster, giving ample opportunity for fruit setting if fertility were normal. The present batch of cuttings now growing in the greenhouse represents the fifth and sixth cutting generations. There are at least 90 of these and they are still uniformly of the original haploid phenotype, indicating no change during the last twenty months. This stability of the tomato haploid condition is of course in distinct contrast to the mutability of the Datura haploid,[3] but it must be recalled that the latter type possesses a much higher degree of fertility through the seed from whence come the mutations which are largely chromosomal number variations. Gene mutations in the tomato seem to be rarer than in Datura so that one does not expect to stumble into them very often, even in a haploid.

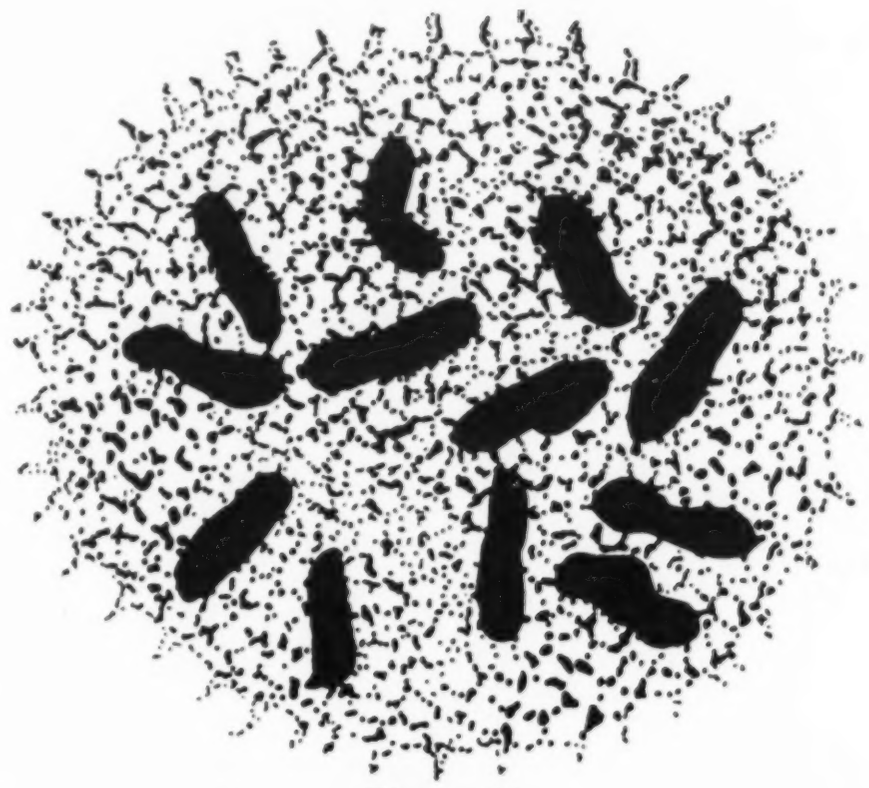

Figure 14

Cell from root-tip of tomato haploid showing twelve chromosomes. Bouin's fixation x6000. Drawing by W. A. Welter.

Apparently the diploid tissue in the haploid is exceedingly rare. Experiments are now under way, however, to stimulate doubling of the chromosome number of the haploid by various external agents. For our studies of the inheritance of fruit size and shape, it will be exceedingly important to eventually obtain an absolutely homozygous type of tomato.

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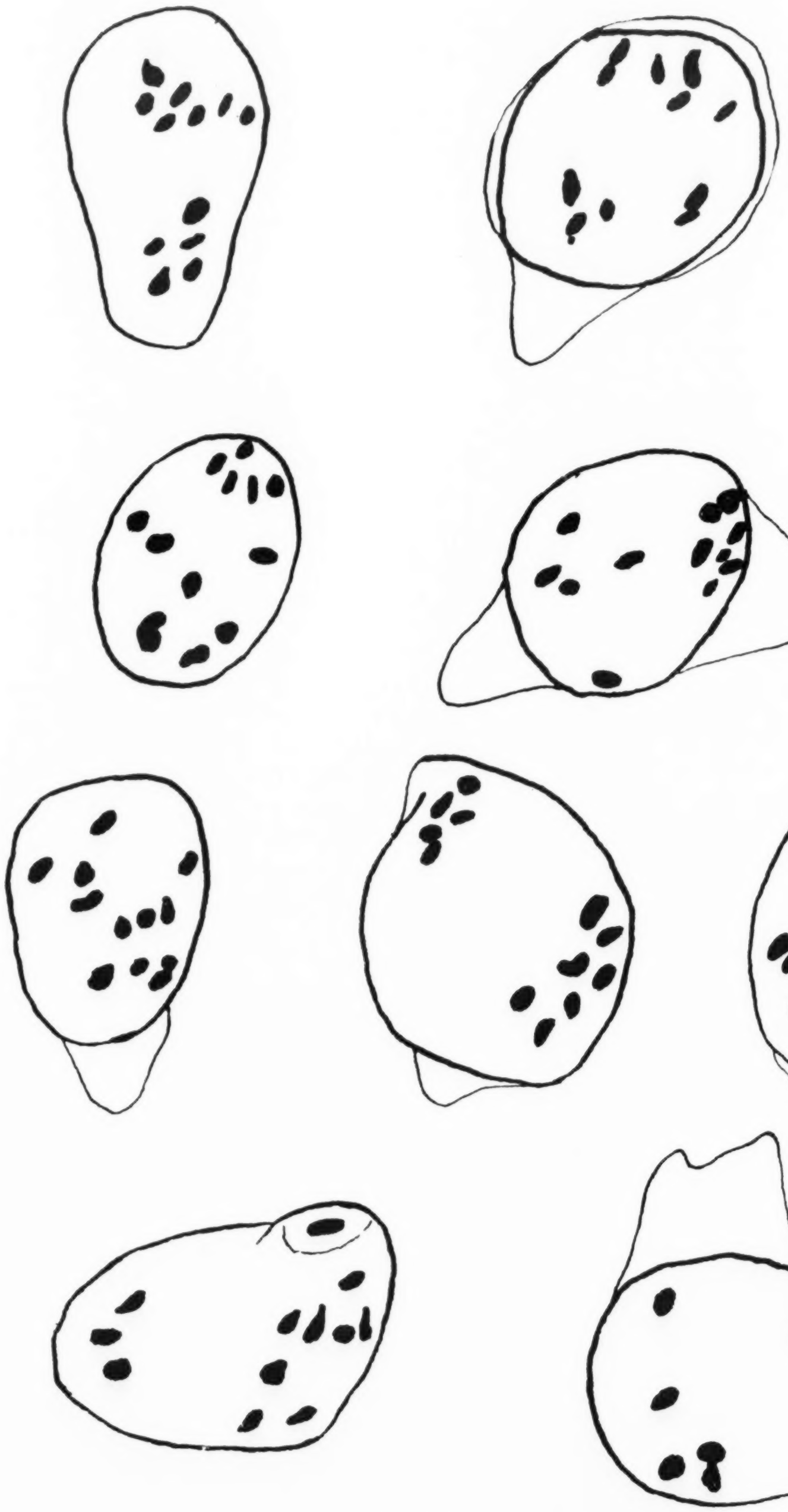
TABLE I—F_2 tetrahybrid distribution in which the haploid occurred. It was one of the five plants in the PdRY class[1], being also a single crossover type PdO, for the first linkage group.

Parents	PD				pd				Pd			pD		Total
	RY	Ry	rY	ry	RY	Ry	rY	ry	RY	Ry	rY	RY	rY	
Red Pear×Dwarf Peach 253-1×250-5 RYPDo×rypdO	69	17	21	10	30	6	3	2	5[1]	1	3	1	0	168
Reciprocal cross 250-5×253-1	58	24	27	13	27	2	10	2	1	1	1	2	1	169
Total	127	41	48	23	57	8	13	4	6	2	4	3	1	337



ATTEMPTED REDUCTION DIVISION

Figure 15

Pollen mother cells from the haploid showing attempts at a reduction division of the twelve univalent chromosomes. Aceto-carmine preparation.

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FROM THE CRADLE OF THE JERSEY BREED

RECENTLY there has come to hand the first copy of a quarterly publication* emanating from the island home of Jersey cattle. The purpose of the magazine is to bring to Jersey breeders all over the world news from the homeland of the breed. If the first issue is a fair sample, the magazine should have even a wider appeal.

The prominent place that the Jersey breed takes in the activities of the island is somewhat of a revelation. Jersey is only six miles by twelve, and it is divided into twelve parishes. Each of these has a cattle show all its own at which there is evidently no lack of competition. It appears that most of those present feel that they are better informed on the fine points of Jersey cattle than the judges, and the result must not be unlike a baseball game in the United States when the umpire makes an unpopular decision. With their critics all about them the judges' position must be even more unenviable than that of the umpire! After the parish shows are over an island sweepstakes is held, at which the leaders of the breed are proudly acclaimed.

Interesting accounts are also given of the parish cattle clubs and of other local matters dealing with the breed. It is proposed to make a feature of articles dealing with the scientific aspects of breeding. In this first issue "The Inbreeding of Jerseys" is discussed. To one interested in Jerseys in particular or to live stock in general this tiny spot in the English Channel assumes a fascinating interest.

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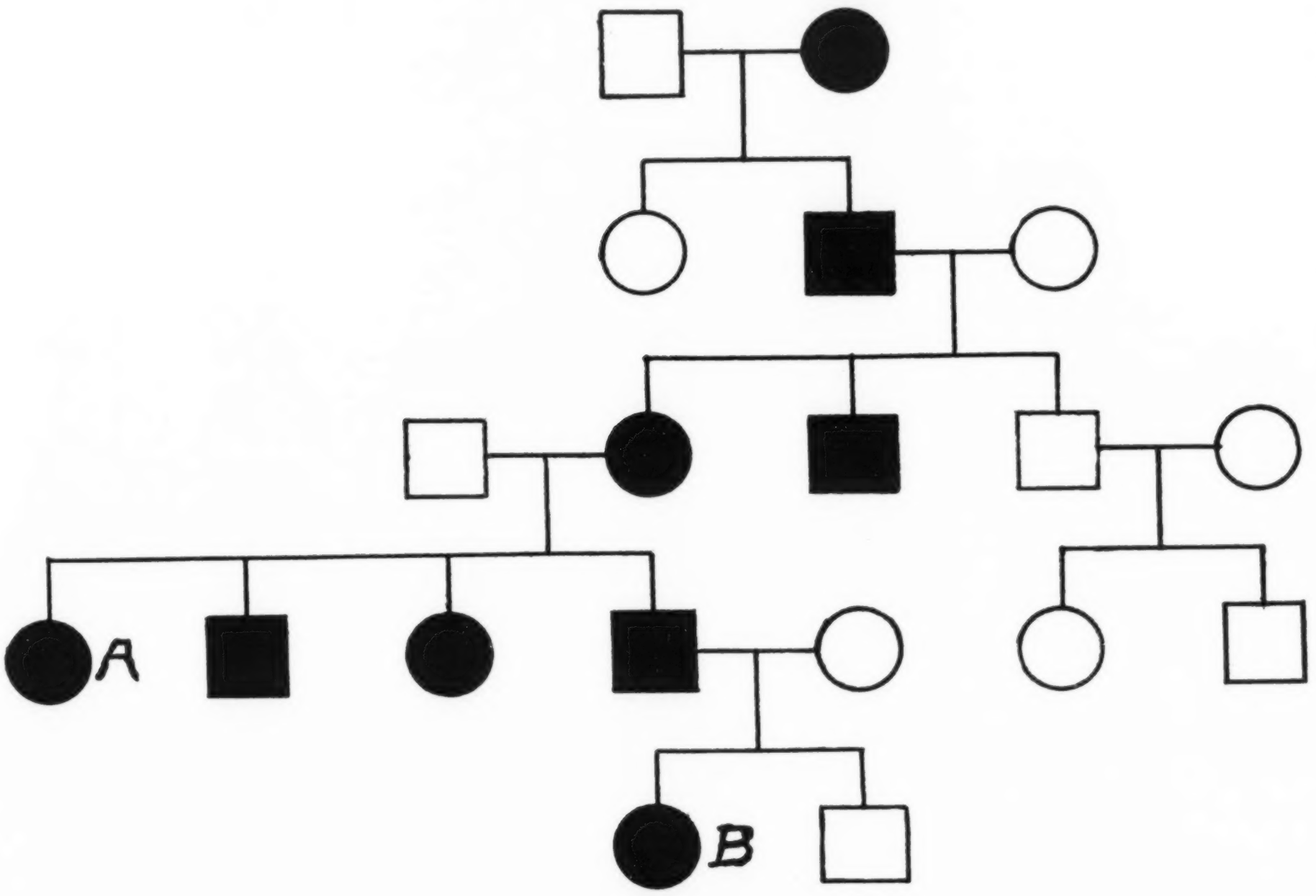
PREMATURE WHITENING OF THE HAIR

HUMPHREY J. H. HARE

Emmanuel College, Cambridge, England



SIX GENERATIONS OF PREMATURE GRAYNESS IN THE HAIR

Figure 16

By the time they were twenty-five the individuals indicated by the black symbols had white hair, with the exception of the two marked "A" and "B." By special care of the hair, they have been able to ward off the change in color that heredity had in store for them.

I HAVE recently become acquainted with a case of premature white hair, which seems to be hereditary. This occurs in a family, one member of which I know, and I can vouch for the accuracy of the following data.

The abnormal persons show no sign of the abnormality until they reach the age of seventeen or eighteen. The hair then slowly turns white, and by the age of twenty-five or twenty-six has completely lost its color. This has happened in every case except two, in which the abnormality appeared. These exceptions, A and B in the pedigree, underwent treatment to prevent the loss of color. At the age of eighteen A's hair was showing the first signs of whitening, but by taking exceptional care of the hair the development of the abnormal condition was checked, and she now has a fine head of black hair. No dyes were used. B, a girl of nineteen, is now undergoing similar treatment, as her hair was beginning to turn white. Both these cases must be considered to be affected.

Above is the pedigree, the affected persons being indicated by black signs.

In every instance the abnormal in-

dividual has had one abnormal parent, and the case can be most simply explained by the assumption that the abnormality behaves as a simple Mendelian dominant.

There is, however. nothing in the pedigree against the assumption that it behaves as a simple recessive. This, nevertheless, is highly improbable, as it would be necessary to assume that the apparently normal parents were, in each case, heterozygous. Since, however, none of the marriages were between closely related persons, and in view of the fact that the condition is not a common one, this explanation seems less likely.

CORRESPONDENCE

Claw-Fingers an Atavism?

With reference to the interesting article by Leopoldo S. Clementi, "A Claw Fingered Family," (*Jour. Hered.* Vol. 19, No. 12), and the author's conclusions that the abnormality of nails of fingers and toes is due to sudden mutation, may it not be equally likely that the occurrence of this deformity is entirely a case of physical atavism?

The conclusion arrived at that mutation is responsible because of absence of abnormality among ancestors of the first afflicted individual seems, in view of the fact that ancestral history is traceable only to his grandparents, to be a rather slender one.

A phylogenetic explanation is suggested on the lines of that given for such well-known varieties as polymastism and the reappearance of certain primitive muscular and organic features the uses for which the race generally has outgrown.

We are aware that comparative anatomy proves that many characteristics that were common attributes to the stem line have, by adaptation, been modified and that others have generally through disuse become atrophied. We know also that through latent heredity and atavism some of these have occasionally recurred. These atavistic characteristics have been transmitted with modifications to offspring for several generations.

The Cretaceous mallotheria and the prosimiae, both of the stem line, certainly had claws from which the nails of ape and man have evolved. We are familiar with "reversion to type" in brain, breast, cauda, muscle and other features—may we not also include finger and toe nails?

W. Brian Peake, f.r.a.i.,
Great Britain and Ireland.

The term "atavism" has been condemned in genetic literature because of its vagueness. While it serves satisfactorily as a phylogenetic classification of a character, we are likely to lose sight of the fact that it tells us nothing about its inheritance. By the nature of the case, atavistic characters can hardly be dominant, and in this instance the possibility of "claw fingers" being a recessive seems rather remote. It would imply that both the parents of the first "claw finger" and his wife were heterozygous. Since the character is not reported to be of common occurrence in the Philippines this would appear to be a rather remarkable coincidence. Another generation at least would be necessary to confirm the dominant inheritance of the character. If it should prove to be dominant, the proponents of an atavistic origin of claw-fingers would be faced with the necessity of explaining its whereabouts during the generations it had remained in abeyance. Certainly

some change must have taken place in the mode of inheritance of the character to make it behave in a different manner, so that it might properly be described both as a "mutation" and as an "atavism."—*Editor.*

Possibilities of Honey Locust Hybrids

I was much interested in reading an article in *The American Fruit Grower* on your quest for superior strains of the Honey Locust. I hope this inquiry will bring forth information that will help to locate the best fruiting trees of this species and that these trees can be used for economic purposes. While reading this article my mind reverted to a scheme which I thought of several years ago, while on the staff of the Manitoba Agricultural College, but unfortunately I have not been able to work out this scheme since then.

In the first place I want to say that my knowledge of genetics is rather limited, as you will easily see when I explain what I have in mind. The project that I would like to see tested out is the feasibility of crossing the Honey Locust with the Caragana (*Caragana arborescens*) with the object of combining the good qualities of each species in the production of a tree suitable for the Northern Great Plains region of the United States and Canada. Both of these species have characters which, if they could be combined, would make a most desirable tree. The Caragana is very hardy, having withstood the severe winter temperatures of the Canadian Prairie Provinces. It is also a handsome tree-like shrub and is widely used for hedge and ornamental purposes. Unlike some other species of the Leguminosae, it can be propagated by cuttings. The chief defect of this otherwise excellent plant is that it is rather small, rarely growing more than 18 feet tall and is thus unsuited for timber or fuel.

The Honey Locust is likewise a desirable tree in many respects. As is well known, it attains a large size, grows rapidly and is a beautiful tree in the thornless strains at any rate. It is useful for hedges, posts and fuel, but unfortunately it is not hardy enough to stand the winters of the Western Canadian Provinces.

There is certainly a need on the Canadian Prairies for a hardy, rapid growing tree suitable for fence posts, fuel and shelter. Such a tree does not now exist and a realization of this need was the main factor that prompted this inquiry.

Perhaps my idea is impossible of fulfillment, but in any case it would be worth while trying by someone who is in a position to undertake this work. If you think this idea has the remotest possibility of realization, I shall be pleased to have you discuss it with some of your colleagues with the object of getting some competent person to undertake this venture in breeding tree crops.

Thanking you in advance for any information that you may have relative to the possibility of making inter-genus crosses in the Leguminosae.

Jas. A. Neilson,
Extension Horticulturist,
Port Hope, Ontario.

Fertile Abyssinian Mules

The popular idea that wide crosses result in sterile hybrids may be due in part to the fact that often not much attempt is made to breed the hybrids further. I have been interested to learn that for a long time in America the mule has been regarded as sterile. I have not given animal breeding a great amount of attention except from the economic standpoint, but I know of one fertile mule. It is not considered, however, good agricultural practice in Abyssinia to breed mules.

Soldiers in Abyssinia furnish their

own horses and mules and mules are used mostly. Welde Tensing, a soldier, was ordered from East to West Abyssinia on a campaign. According to custom, he took his wife with him. They rode on two large, well-fed saddle mules. One of the mules was a female. After they had been several days on the road, shortly after breaking camp one morning, the female mule refused to go further and a little later laid down. They supposed she was sick, but while they went about doctoring her, to the amazement of all concerned, she gave birth to a colt. The colt died in a few minutes, which is not so remarkable considering the conditions under which it was born. It is not known for sure regarding the sire of the colt, but in Abyssinia most stallions are kept apart and there are plenty of opportunities for mating with uncastrated asses in grazing and watering, and in all probability the sire was an ass.

BASHAHWARAD HABTERWOLD,
Muskingum College, Michigan.

The Beginnings of Wisdom

IN a little volume* of less than a hundred pages, dedicated to Henry Louis Mencken, Raymond Pearl of Johns Hopkins University presents a list of seventy-five books which might profitably be read by graduate students. This little book began as a magazine article entitled "The Reading of Graduate Students," which was originally published in *The Scientific Monthly*, July, 1925.

Old students and friends in all parts of the world urged Dr. Pearl to expand the original article and give it the more general availability which book publication affords. This he has done so interestingly that members of college and university graduate faculties will quite generally want to own *To Begin With* and hand it to their graduate students as one of their first intellectual feasts. The general reader will also find this little volume of interest, for Pearl has kept the generalized graduate student in mind, realizing that to be a student one does not have to be registered in a university.

Because of the increasing organization, standardization, mechanization and constant striving for efficient mediocrity in all our university and college life, Dr. Pearl asks: Is it not about time to consider seriously the subject of the freedom, within academic precincts, of the student to develop his intellectual powers in the way he personally wants to?

Pearl feels that graduate study should give its practitioner a comprehensive, justly balanced and critically related knowledge of the particular field whose charms have seduced him.

It is now quite possible, according to Pearl, for a boy to go straight through from his letter blocks to his Ph. D. with precisely the same kind of cooperation in the enterprise on his part that a sardine furnishes to the business of his translation from the state of innocence and freedom of his birthplace to the diploma-bearing tin on the grocer's shelf.

To aid in the progress of graduate students along their appointed chutes, Pearl has found directed reading a useful method. The student does something for himself, and makes contact with the great minds that have built the structure whose architecture he must know before he can add his bit to it.

Obviously, a selection must be made from the treasures at command, as the student cannot read in his brief period of residence as much as his instructor has in his professional life. Pearl is sure that to make out lists of highly technical researches in the particular field of interest is a mis-

*TO BEGIN WITH, by RAYMOND PEARL, Johns Hopkins University. Price, $1.50. Published by Alfred Knopf. New York, 1927.

take. Rather the obligation is to put in the way of the student the means of orienting himself relative to his subject on the one hand and to the general corpus of human learning on the other hand. If the student amounts to anything he will then guide himself to the technical reading in his chosen subject better than anyone else can steer him.

Pearl's list of books is divided into four main parts: Underpinning, Living, Biology and Bio-statistics.

The reviewer cannot hope for space to list more than a very inadequate random sample of the titles in each section, but even a few selections from the complete list will illustrate its catholicity.

Underpinning

Seneca, Questiones Naturales; Aristotle, Historia Animalium; Whitehead, Science and The Modern World; Bacon, On the Dignity and Advancement of Learning; Whewell, The History of the Inductive Sciences; Pearson, The Grammar of Science; Schiller, Formal Logic; Buckle, History of Civilization in England.

Living

Pearl writes: The branch of Science which underlies the art of conducting life is called ethics. The student must work out an adjustment between the claims upon his life of his sicence, a proverbially jealous and exacting mistress, and those of the rest of the world, including not only deans, committees, commissioners, directors, boards, foundations and other great cosmic elements but also cooks, maids, nurses, children and, most important of all, his wife. Reading the following works and others in the complete list should aid the student in making these adjustments, and in really *living:* Mencken, In Defense of Women; Fowler, A Dictionary of Modern English Usage; Brewster, Memoirs of Sir Isaac Newton; F. Darwin, The Life and Letters of Charles Darwin; Galton, Memories of My Life; Pearson, The Life, Letters and Labours of Francis Galton; Radot, The Life of Pasteur.

Biology

Pearl states that the purpose of the list of books in this chapter is to give the reader some idea of the historical background of this branch of Science. Foster, Lectures on the History of Physiology During the Sixteenth, Seventeenth and Eighteenth Centuries; Harvey, An Anatomical Disquisition on the Motion of the Heart and Blood in Animals; Lamarck, Zoological Philosophy; Lyell, Principles of Geology; Darwin, The Origin of Species; Galton, Natural Inheritance; Weissman, Essays upon Heredity and Kindred Biological Problems; Bateson, Mendel's Principles of Heredity; Wilson, The Cell in Development and Inheritance; De Kruif, Microbe Hunters.

Bio-Statistics

Just as in the case of biology, the following list of books for the beginning student of vital statistics must be regarded as merely introductory: Malthus, Essay on the Principle of Population as it Affects the Future Improvement of Society; Whitehead, An Introduction to Mathematics; Todhunter, A History of the Mathematical Theory of Probability from the Time of Pascal to that of Laplace; Pierce, A Theory of Probable Inference; Galton, Inquiries into Human Faculty and its Development; Yule, An Introduction to the Theory of Statistics.

Pearl adds that youth ought to have some religious guidance in the matter of conducting life, and to this end he suggests five books. Among these are: This Believing World, by Lewis Browne, and A History of the Warfare of Science with Theology in Christendom, by Andrew Dickson White. Pearl considers that when the student has read the five religious treatises recommended that his religious education will have been well attended to. Many college and university men will not concur in this opinion.

John H. Parker.

A PONKAN ORANGE GROVE Photograph by Professor G. W. Groff

Figure 17

Scene in Ponkan grove in Kwantung, China. This variety is one of the most popular in the Orient.

THE BEST ORANGES OF THE FAR EAST

An Account of the Ponkan, Tankan, Kosho-Tankan and Haili from Formosa and the Adjacent Chinese Coast

TYOZABURO TANAKA

Director Tanaka Citrus Experiment Station.

ON the occasion of the Third Pan-Pacific Science Congress, held in Tokyo in 1926, the writer called attention to the fact that the best Citrus fruits of the Far East were entirely unknown to the other Citrus growing regions of the world.[9] As a matter of historical record, the sweet orange (*Citrus sinensis* Osbeck) of China was introduced into Europe in the fourteenth century and developed into a much larger industry than in its home country. The Mediterranean mandarin is unquestionably of Chinese origin, though the writer's studies show that there is no orange in China that is identical with it. The Japanese Satsuma orange has succeeded very well in the Gulf Coast region of the United States of America, but no other orange of the Orient has yet been regarded as of sufficient value to be planted on a commercial scale. This, of course, does not mean that there is any lack of fine commercial oranges in the Orient; it is merely due to lack of reliable information on the subject.

Statistics show that a considerable amount of the Mi-chieh orange is exported from Swatow. This orange, while generally called a mandarin by the western inhabitants of Shanghai and Tienchien, is entirely different from the Mediterranean mandarin of the Europeans. One must remember, too, that still larger amounts of the true tangerine orange are exported from Fuchow. This is called Fu-chieh, and also, without exact reference, mandarin. The Canton orange, or true sweet orange, is distinguished by the name Chêng, or "Coolie orange."

The best of all is unquestionably the Swatow orange, but, unfortunately, there is as yet no reliable information to show its true character. In the winter of 1925, the writer made a trip to this region and verified the orange as identical with the Ponkan of Formosa[8] which had been previously studied and described by him as a very profitable kind of Citrus.[5] The growing center of the Swatow orange is Chao chow, where it is called either Panhan or Bitankan. The production of Ponkan oranges in Formosa reaches a value of 500,000 Yen annually, but under Government encouragement it will soon grow to be a 1,000,000-Yen industry and rank as one of the most important crops of the island.*

Bonavia's description of Suntara of

*The following technical description shows its detailed characteristics: Fruit 8-7 cm. diam. depressed lobose to oblate, often quite rectangular and tall; apex deeply depressed and always with typical radiating furrows. Navel present or absent. Base flattened or projected, with irregular furrows. Surface oily, bright-colored, Cadmium orange† (Ry III), even but generally pitted on apical half; oil cell dots uniform and crowded, forming miliary convexitis; calyx small, lobes smply triangular, thin. In cross section rind moderately thick, wavy along segments; oil cells prominent, not uniform; central column very large, hollow, fibre nearly isolated. Segments 9-13, mostly 10-11, much rounded outside and pointed inside, in peeled fruit they form long crescents; walls very thin and easily separable from each other; pulp bright-colored, near salmon orange (Ry II), sweet, aromatic and excellent quality, soft anl juicy but sometimes becoming hard. Pulp vesicles coarsely interwoven in reticulation, never becoming parallel; individual vesicles large, plump, angular, many attached to side wall, often becoming hard by losing juice. Seeds few, small, plump, apex rounded, base generally beaked, nearly smooth, tegmen at charaza, onion-skin pink (Ry XXVIII). Embryo 2-3, green.

†Reference to color is based upon RIDGWAY, Color Standards and Nomenclature, Washington, 1912.

Photograph by G. W. Groff

PECULIAR GROWTH HABIT OF PONKAN MAKES CLOSE SPACING POSSIBLE

Figure 18

The upright habit of growth of the Ponkan enables the grower to plant as many as 900 trees to the acre. The gross income from the Ponkan orchards runs as high as $1,800 per acre per year, one of the most profitable citrus industries in the world.

Poona[1] fits with the Ponkan, and judging from the fact that its close relatives, like Djeroek Pasch and Djeroek Garoet of Java, and Jamanaran of Ceylon, flourish in the tropics, Ponkan appears to be a tropical species and no relatives are found in Japan and China. Only the Su hoi kam of Canton and the Genshôkan of Formosa resemble it, and they only slightly. It stands by itself and should not be confounded with any mandarins or tangerines.[6,7]

The importance of the Ponkan was first reported by Tashiro[10] and a few plants were introduced into Japan in 1896. Tamura[4] reports the succeeding introductions but the climate of Japan is not warm enough to produce marketable fruits. The writer once received from America a fruit identical with the Ponkan. This was labeled Kinneloa. It has received no especial attention and attracted no particular notice, perhaps for want of a close study of its behavior. It appears to be suited for culture on a large scale on various stocks such as the trifoliate orange, Sunki and Calamondin, *Citrus microcarpa* Bunge. The tree is a moderately upright bush and its abundant foliage gives it a healthy and beautiful appearance. The fruit is extremely attractive and can be preserved as a sweetmeat.

The writer found a number of varieties of Ponkan in various places. In Chao chow there is a large flat kind with rather small leaves. These appear in abundance but occasionally one finds very smooth-skinned fruit in the stores of Swatow, which oranges probably come from special trees. In Formosa a round-fruited strain with larger leaves is much appreciated and the Government propagates this type only through very strict performance records. It is planned to distribute during the present year (1928) 800,000 labeled pedigreed trees. This procedure is being followed to prevent the importation of inferior plants from the opposite Chinese coast.

In Chang chow, Fukien, China, a distinct late-maturing variety is under cultivation. This is called the Tan-lo, and has a smaller fruit with a very tight, elastic rind. In Fuchow a small hardy type called the Lien-chen-chü was also found to be a variety of the Ponkan.

The Ponkan is not as hardy as the Satsuma but it can be grown in the southern part of Japan. It requires much heat but is resistant to both dry and wet climates. It is grown under irrigation in Chao chow, where the plants are very closely set and yield very large quantities of fruit, with extremely profitable returns to the growers. The Formosan growers are beginning to realize the profits from this crop and there is a growing and increasing demand for the oranges in Japan proper, the fruits bringing sometimes as much as fifty cents (Mexican) each. It seems likely that the Ponkan will prove worthy of trial in Florida and may also find a place in California orange growing if it is planted and cared for properly.

The Tankan

Very little is known of the Tankan of Formosa, *Citrus tankan* Hayata. Tamura[3] first describes its merits but he has selected the wrong name, a name applicable to the Ponkan in Chao Chow. Tankan is grown in Chang chow and there it is called Tankan; but in Chao Chow the Bitankan is Ponkan, and this is exclusively called Chao kan. Tankan of Formosa is probably its modern name, and the farmers call it Nienkan, which may be its appropriate and correct name. It grows in a wild state in the mountains of Formosa and the account of edible fruits appears in the mythology of aboriginal tribes. It may therefore be an indigenous species of the island because it does not occur in any other place beside the opposite Chinese coast, and its varieties are known only in the island.*

*The typical Tankan fruit is described as follows: Fruit medium in size, 6-7 c.m. diam., quite rounded or slightly flattened at ends; apex not concave, stylar end only punctate, rough-

Ponkan

Haili

Tankan

Kosho-Tankan

Tankan (apical view)

ORANGES OF FORMOSA

Figure 19

The Ponkan is the best of the oranges grown in Formosa, with the Haili next and the Tankan third. The Kosho-Tankan is an improved variety cultivated mostly in Northern Formosa. The Ponkan appears to be a tropical species and no relatives are found in Japan or China. The Tankan is probably indigenous to Formosa.

Ponkan

Kosho-Tankan

Haili

an improved variety cultivated mostly in Northern Formosa. The Ponkan appears to be a tropical species and no relatives are found in Japan or China. The Tankan is probably indigenous to Formosa.

Ponkan

Kosho-Tankan

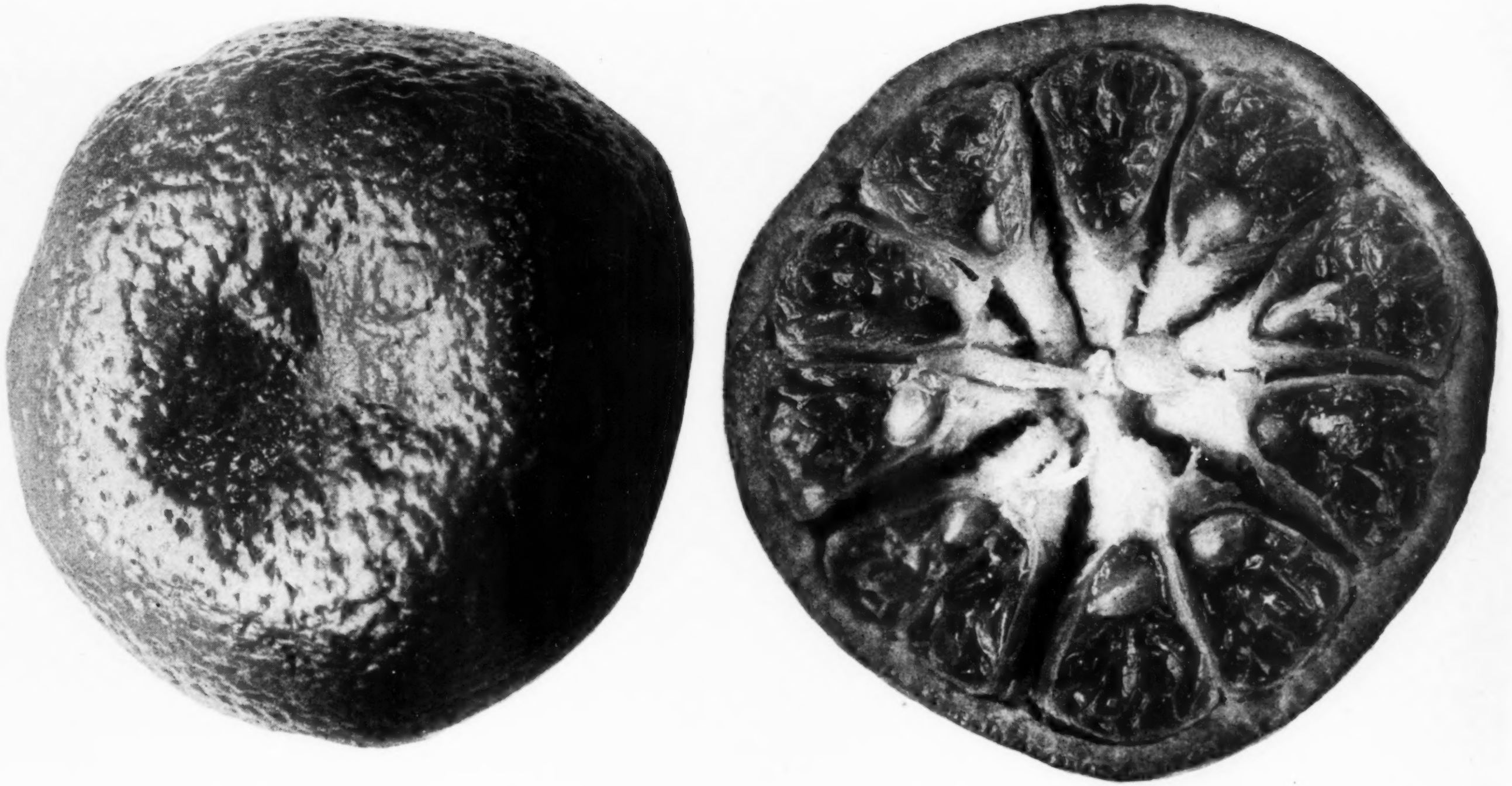
Haili

Tankan

SECTIONS OF FORMOSA ORANGES

Figure 20

The ponkan is a loose-skinned orange like the tangerine; the tankan is an ally of the sweet orange. The fruits of the ponkan sometimes bring as much as 25 cents apiece in Japan.



FLORIDA-GROWN PONKANS

Photograph by E. L. Crandall

Figure 21

The ponkan oranges in Florida trace back to a seedling raised from seed sent by a Dr. Parks, a missionary in China. It was planted about 1892 on the property of J. C. Barrington, McMeekin, Florida. It has been called "Wanurco Tangerin" and "Chinese Honey Orange." The ponkan in Florida has not been grown on the dwarfing stocks used in the Orient, which are considered to produce the best results.

The Ponkan is at any rate a loose-skin orange, like the Satsuma, tangerine, King orange and Mediterranean mandarin; but the Tankan is an ally of the sweet orange. Ponkan has a solitary flower arranged in a small raceme, and round fruit with apical depression. The latter has a rind easily peeled off, separable segments and seeds with green embryo. The sweet orange never has such characters. The Kôshô-Tankan is an improved variety of Tankan cultivated mostly in northern Formosa near Taihoku. It blooms late and bears larger fruit, maturing a month later and being of better quality.

Haili is another orange that closely resembles the Tankan. Hayata[2] maintains that it is a variety of the Tankan, but a careful study by the writer shows that it has a solitary flower and that the fruit characters are also different. The fruit of the Haili is still larger than the Kôshô-Tankan, and somewhat flat and very smooth; also it often changes to a reddish color. The pulp vesicles are very fine and closely netted. It has the strong fragrance of an orange grown in Quelpart and Japan proper, where it is called Daikôji. This orange is unquestionably derived from the Tanakn, which is closely resembles, but it is not the Tankan.

A Formosan farmer's comparison of the Ponkan, Haili and Tankan is very interesting: Ratio of planting of the three in Shinpo district in Formosa is 7-2-1. The picking season for the Ponkan ranges from the latter part of December to January 10; for the Haili from January 2 to 20; and for the Tankan from January 15 to 30. The Ponkan fruit is stored until April 15; Haili up to April 20; and Tankan to the end of April. The crops of these trees are in a 10-9-8 ratio and the price 10-7-5. Fertilizer used is in a ratio of 10-7-7. Wind damage is greatest to the Ponkan and so in years when typhoons are prevalent the income will be in a ratio of 1-1.5-1.8-2. One must expect about two severe windy years and one very bad year in every ten. Ponkan is damaged most severely by stem borer and it suffers from cold very much in severe years, so that the fruit must be harvested much earlier which, of course, results in lower prices. Taking everything into consideration the average profit of the three kinds will be in a ratio of 30-27-25.

Careful tests of the flavor of the fruit show the Ponkan as ranking first; Haili second; and Tankan third. The Government highly recommends the planting of the Ponkan, but the growers are reluctant to abandon the others. Formosan Ponkan is exported to Japan proper in quantity but under strict quarantine against mango fruit fly and Phoma spotting. The price is very high and the demand great. Parcels Post delivery is now under trial and if it works out satisfactorily will be a great advantage to both the grower and the consumer. There is also a large demand for the Ponkan in the Asiatic coast cities, and even the Manchurian cities receive larger quantities of the Ponkan than of the Japanese Satsuma. Tankan ships very well and the fruit is found abundantly in the Malay Peninsula during the winter months. Unfortunately, they are too tropical to be grown in Japan proper, and it is almost impossible to accept Tankan fruits in Japanese ports because the Phoma spotting is so bad. It is very evident that the occurrence of *Phoma citri-*

ened and areolate, base more or less grooved. Surface even, finely crepe-wrinkled, like sweet orange; Capucine yellow to orange (Ry III); oil cell dots graded, very small, not always convex, sometimes roughened at apex. Calyx not small, but lobes short. Section scented, rind rather thin, uniform in thickness; oil cells large, round, much different in size; central column small, pith rather dense; segments very uniform, 9-11, rather adherent, but separable. Pulp capucine yellow to orange, very meaty, soft, sweet, aromatic, not drying; good quality, but not so agreeable as Ponkan. Pulp vesicles arranged like salmon flesh, gathered to the central line, many attached to side wall, individual vesicles long, fusoid, curved, very flexible, rather easily broken. Seeds few, obovoid, medium large, plump, brownish, tegmen at charaza purplish, embryo 2-4, creamy to light green.

carpa is much dependent on temperature and the disease is worse progressing southward along the Chinese coast.

Chao chou is the most advanced section among the Chinese coast Citrus regions and the cultural technique followed with the Ponkan there is deserving of close attention from Citrus growers elsewhere. Above all, is the amazing fact that Citrus plants can be so closely set in an orchard without any interference with cultivation. In Chao chou the average planting distance is 8×6 feet, making 900 trees to the acre. The farmer's gross income will be from 2,400 Yüan to 3,600 Yüan to the acre—about $1,200 to $1,800 gold. This is perhaps the most profitable demonstration to be found among Citrus growing countries.

The fact that such close planting is possible is due primarily to the upright habit of the Ponkan tree, but cultural methods conforming to and making the most of the exceedingly upright habit of the tree have much to do with making the close planting feasible. Trees are not allowed to live more than twenty years or so, the renewal with young plants being necessary to keep the orchard young and productive.

The standard or main upright trunk of the tree is fixed at 1.4-1.5 feet and all necessary branching from this part of the tree is eliminated so as to keep the bearing shoots constantly arising from the vigorous upper part. Leaders are all shortened by pruning. Fertilizers which might affect the abrupt growth of unproductive water sprouts are all discarded and only slow-acting kinds· such as ox bone, are applied between the trees. The trees are constantly irrigated during the winter months but the water is run only in shallow grooves between the tree rows and not directly soaking the major roots. Every practicable care is taken to dwarf the trees so that they look something like lemon trees in Italy, trained as dwarf trees, with the crop kept around the side branches. It is a beautiful sight when the trees are bearing heavy crops of large, bright-colored fruits. Each fruit is stamped with the owner's seal to protect against robbery. The single trunk training of the Ponkan is distinctly new, since the plant tends always to branch low in a bushy, vase-like shape which occupies much space. The new method of training was instantly recommended to the Formosan growers of this variety and is now recognized as one of the most important factors in successful Ponkan culture.

Southern China, especially Fukien and Chekiang, is very imperfectly explored from a horticultural standpoint, and many other interesting Citrus fruits are growing there which are but little known to the outside world. There is, for example, the Wenchou orange, which has been grown for 750 years; the T'ientaishan orange, which brings the highest price in the Shanghai market; the Ts'aokieh or early mandarin orange of the King type; the Mankieh or late orange· a relative of the Satsuma; and so on. Thorough study and the wider distribution and acclimatization of these now imperfectly known Citrus fruits may throw a new light on the fundamental considerations in the choice of varieties.

AUTHOR'S NOTE:

In the writer's recent trip to Florida it was found that the Ponkan had been introduced into this country by seeds sent from China by Dr. Parks, an American medical missionary, during the period 1892 to 1893. Mr. J. C. Barrington, McMeekin, Florida, received two fruits of Ponkan from Dr. Parks and he raised several seedlings. One of these trees found in the garden of Mr. Frank Jerkins, near Melrose, Florida, was studied by the writer and was verified to be true to type. Two similar seedlings from the same introduction are said to be growing on the Barrington place near McMeekin, Florida. Plants have been propagated

from these seedlings and are locally called "Chinese honey orange", perhaps derived from the Chaochou name "Honey barrel". The Wartman Nursery Company propagated this orange a few years ago under the name "Wanurco", but both these names should be discarded and "Ponkan" used as the standard name of this plant, as it is universally called by this name in Formosa and Kwangtung-Fukien provinces in China.

It was also found in Florida that some of the early government introductions of the "Ponkan" were in reality "Tankan", a later maturing bright colored fruit of semi kid-glove character.

As to the proper rootstock for these plants, trial should be made of budding them on Sunki and Ponki, both of Chinese origin and now under close observation by the U. S. Department of Agriculture. The latter is identical with the Cleopatra mandarin, rarely cultivated in Florida and California, and now found to be a promising root stock.

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The Bootleg Prospect

"My ole woman say she beleev we goin' to have a whole nashun a bootlegger purty soon. She watch 'em try a lot a bootlegger in Uncle Sam court house one day an she notis that evry one a them wimmin bootlegger had more chillen with her than all them wimmin what belong to ladies aid with her ever did have all of them put together."—"Poor Lo," in *The Oklahoma Farmer-Stockman*, October 1, 1928.

POPULARIZING THE DASHEEN

THE dasheen is an aroid, *Colocasia esculenta*, related to the elephant ears of our flower beds. The edible parts grow underground: one eats the large central corm and also the smaller curved cormels that sprout from its sides.

Dasheens, like potatoes, can be cooked in a variety of ways, they are particularly good riced or baked, but should be served with drawn butter or gravy as they are much drier than potatoes. They make a delicious salad when boiled and diced and mixed with mayonnaise, but perhaps they are nicest of all when made into fluted crisps, to be eaten with the fingers like crackers.

Mrs. James Jardine, wife of the Secretary of Agriculture, in acknowledging some crisps sent her, said:

"I used some on my tea table Wednesday afternoon. The ladies thought them very good and superior to the potato, as they are so free from fat."

Mrs. Alfred Mitchell, a sister of Mr. Louis Tiffany and mother-in-law of Senator Bingham of Connecticut, who is a winter resident of Miama writes:

Can you tell me why dasheens are not more known and appreciated in Florida? I was fond of Taro, the Hawaiian Island food, and since you told me that the dasheen of Florida is the same thing and I could cook it in the same variety of ways I have never been without a supply.

Curiously enough, not only my Northern guests but those who have lived in Florida much longer than I have, seem at my table to consider it a new and delightful food, and ask me where they can get it.

I cannot understand why it is not more used, and why the hotels, who like to present novelties on their tables, do not know dasheens.

The best varieties of dasheen were introduced by the Office of Foreign Seed and Plant Introduction of the Department of Agriculture and distributed throughout the Southern states. They grow well in Florida, Alabama and Texas but, so far, the finest texture and flavor are produced on the deep sandy soils of northern Florida, and at Callahan they have been so outstandingly successful that the growers have formed a little Dasheen Association, the first of its kind in the world.

No experimental epicure can fail to be interested in helping to establish this new plant industry on a paying basis.

DAVID FAIRCHILD.

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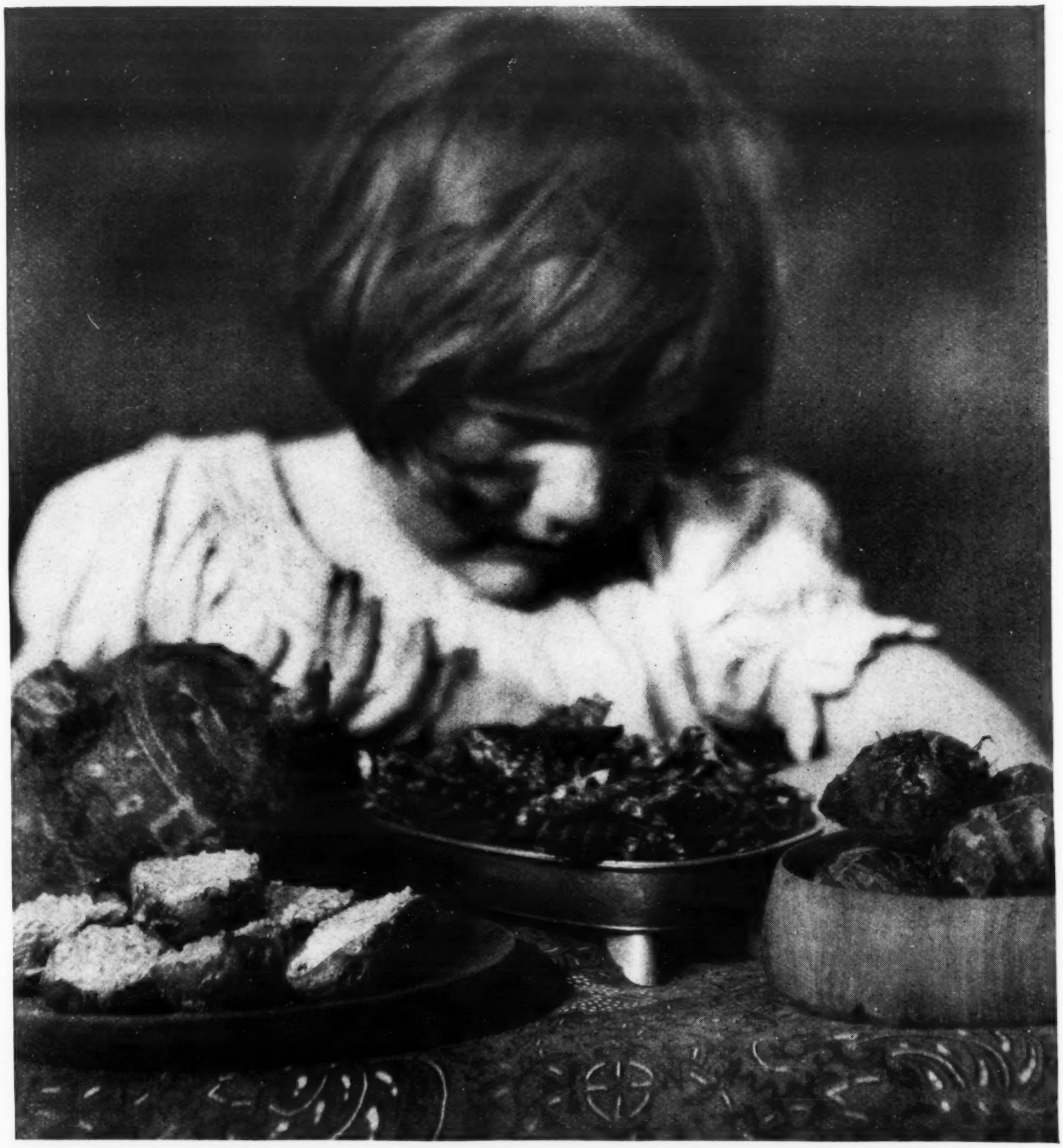

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And likes the tomato
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